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Evaluation of Properties of Architectural Coatings

DL Labs.
New York

Prepared for

California State Air Resources Board
Sacramento

22 Sep 80

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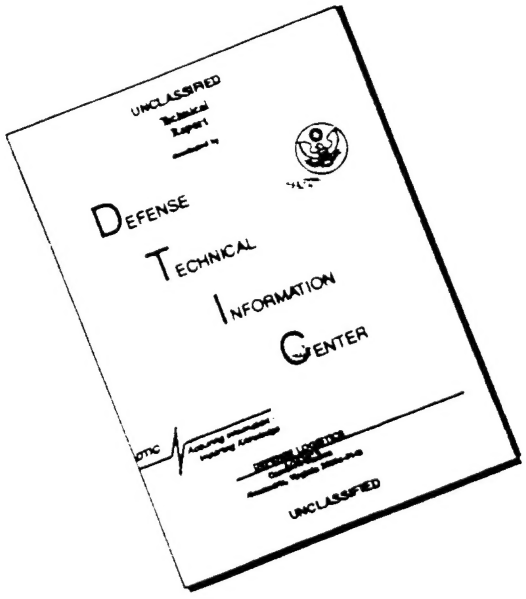

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DL-3028

EVALUATION OF PROPERTIES OF ARCHITECTURAL COATINGS

Agreement #A8-095-31

September 22, 1980

Jerry H. Willner
Group Leader

Saul Spindel
Technical Director

Sidney B. Levinson
President

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This report presents the results of a project to evaluate the performance properties of recently developed water-based and low-solvent architectural coatings to determine if these products have properties equivalent to the conventional high-solvent products which are now used for the same purposes. Architectural coatings are paints and related products applied to stationary structures such as buildings and plant facilities. The classes of coatings evaluated included clear finishes, opaque stains, metal primers, wall primers, wood primers, tile-like glazes, waterproof coatings, maintenance topcoats, swimming pool paints and mastic coatings. These classes, and five other classes for which no samples were available, are exempt from the Air Resources Board's model rule for maximum solvent content because no suitable water-based or low-solvent coatings were available at the time the rule was adopted. Standard ASTM test methods were used. Some of the new products tested had performance properties equivalent to or better than the conventional high-solvent architectural coating products.

The appendices contain test data and procedures.

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ABSTRACT

The paint and coatings industry was surveyed in order to obtain data on and samples of Architectural Coatings among the fourteen classes presently exempt from the California ARB Model Rule for Architectural Coatings and which have low levels of volatile organic compounds (VOC). Data and samples of their conventional counterparts were also requested to enable a direct comparision.

As a result, a total of 89 coatings, claimed to conform to or approach present CARB limitations on VOC, were evaluated vs 57 equivalent conventional coatings. These products accounted for ten of the fourteen exempt classes.

Upon closer examination, it was found that the fourteen classes were so broad in scope that they had to be expanded to a total of twenty five classes and sub-classes, of which nineteen were evaluated. No products were obtained for six classes or sub-classes.

Results of laboratory tests and accelerated laboratory exposures demonstrated that a total of 18 CARB conforming products, among six classes of the total of twenty five, can be considered to be competitive to equivalent conventional products. An additional 7 CARB*conforming products among an additional six classes can be considered to be marginally competitive because of a relatively minor defect.

* California ARB or California Air Resources Board.

ACKNOWLEDGEMENTS

The key personnel responsible for this project were:

Sidney B. Levinson	President
Saul Spindel	Vice President and Technical Director
Jerry H. Willner	Senior Chemist and Group Leader

This report was submitted in fulfillment of ARB Contract No. A8-095-31 "Evaluation of Properties of Architectural Coatings" by the David Litter Laboratories, Inc. DBA D/L Laboratories under the sponsorship of the California Air Resources Board. Work was completed on May 31, 1980.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

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I SUMMARY AND CONCLUSIONS

This investigation was conducted to obtain and evaluate CARB conforming architectural paints and coatings among the fourteen classes of products presently exempt from the California ARB Model Rule for Architectural Coatings. These products were to be compared with equivalent conventional (solvent-thinned) paints and coatings, preferably from the same suppliers, in order to determine whether each CARB conforming class, as a whole, was competitive with the equivalent conventional porducts and therefore can be removed from the exempt list.

In order to reach as broad a source as possible, publicity releases were sent to 23 industry publications and industry associations. Ultimately, over 500 letters and questionnaire forms were sent to paint manufacturers and raw material suppliers throughout the United States. Furthermore, the limits of volatile organic compounds (VOC) were increased from 250 grams per liter of paint, less water, to approximately 350 grams per liter in order to encourage participation in the project.

The result was the receipt and evaluation of a total of 89 CARB conforming paints and coatings and 57 equivalent conventional coatings representing ten of the fourteen exempt classes.

Upon review of the samples and data received, it was evident that some of the exempt classes are too broad in scope and therefore had to be subdivided into sub-classes. The entire list of classes and subclasses is shown in the conclusions below. In addition, as least one class (Unpigmented Coatings) had to be retitled Clear Finishes since semigloss clear finishes are produced by pigmentation with essentially transparent silica pigments.

The evaluation was carried out using laboratory test methods and accelerated exposures commonly used in the industry. The properties evaluated were limited to those of major importance for each class in consideration of the time required for completion. The results of the tests were then summarized using a simple rating scheme of 10 to 0 in order to enable analysis of the data without the necessity of having a coating technology background.

The following conclusions may be drawn form the results of this evaluation:

Class	Product	Competitive	Marginal
1	Clear Finishes		
1A	Interior Gloss	None	1-15
1B	Interior Semigloss	1-17	
1C	Exterior Gloss	None	
1D	Exterior Semigloss	None	
2	Semi-transparent Stains	None	
3	Opaque Stains	3-1,3-7,3-12,3-14	3-3
4	Primers, Sealers, Undercoaters		
4A	Metal Primers		
4A-1	One Package	4-42	
4A-2	Two Component	None	
4A-Z	Zinc Rich	None	4-33
4B	Exterior Wood Primers	4-3,4-11,4-41	
4C	Interior Wall Primers	4-12,4-19,4-22,4-25,4-45	
4D	Enamel Undercoaters	No samples	
5	Wood Preservatives	No samples	
6	Fire Retardant Paints	No samples	
7	Tile-like Glaze Coatings	None	7-5,7-6
8	Waterproofing Coatings	None	8-6
9	Maintenance Topcoats		
9A	Light Duty	9-2,9-4,9-15,9-27	
9B	One Package	None	
9C	Two Component	None	
10	Metallic Paints	No samples	
11	Swimming Pool Paints	None	11-1
12	Graphic Arts (Sign) Paints	No samples	
13	Mastic Coatings (15 mils +)		
13A	Waterproofing	None	
13B	Texture	No conventional samples	
14	Multicolor Paints	None	
14 25	Total Products	18	7
	Total Classes of 14	4	6
	Total Subclasses of 25	6	6

II RECOMMENDATIONS

General

It is apparent from the results of this evaluation that products in the exempt list which readily meet the CARB VOC limit of 250 grams per liter of paint, less water, are limited. Therefore the exempt list is still valid for most architectural paint classes presently included.

However, it is evident that the requirement for low VOC concentrations, which also is being promoted by the Environmental Protection Agency (EPA), is a technology that is becoming more attainable by the Paint and Coatings industry. Furthermore, Government agencies which use paints and coatings, such as the Army, Navy and Federal Highway Administration, are considering the specification of low VOC coatings. Therefore, there is an accelerating development of this technology and thus of CARB conforming products.

Therefore, it is probable that, if a program such as the one covered in this report were repeated in one or two years, the number of conforming products would be much greater. Paint manufacturers will have had more technological experience so that there should be many more low VOC products readily available in the market place.

Additional Samples

Samples of the following products have been received since the cut-off date of December 31, 1979.

Class		CARB	Conv.
1A	Clear Interior Gloss	1	
1C	Clear Exterior Gloss	1	
2	Semi-transparent Stains	2	2
4A-1	Metal Primers - One Package	1+2*	
4D	Enamel Undercoaters	1	1
6	Fire-retardant Paints	9	1
7	Tile-like Glaze Coatings	1	
8	Waterproofing Coatings	2	
9A	Maintenance Topcoats - Light Duty	2+2*	2
9B	Ditto - One Package	2*	
9C	Ditto - Two Component	3*	1*
10	Metallic Paints	2	1
11	Swimming Pool Paints	4	
13B	Mastic Coatings - Texture	4	1
		30+9*	8+1*

* From raw material suppliers

All of these additional samples represent classes which had either none or a limited number of CARB conforming products which were found to be competitive with equivalent conventional coatings. Three (Class 6, 10, 13B) represent classes for which no samples at all were tested in this project.

Inasmuch as the technology of formulating CARB conforming coatings has been developing steadily, it is likely that the testing of these additional coatings will lead to the removal of more coatings and classes from the exempt list.

Further Tests

1. An additional test of major importance is the field exposure testing of exterior paints. Although laboratory accelerated exposures are conducted for the sake of expediency when testing new products, exterior paints should also be subjected to actual exposure outdoors. There are a number of exposure stations located primarily in Florida, as well as in other locations such as Arizona with a high concentration of sunlight, and Puerto Rico with a climate having both a high level of sunlight plus high humidity which accelerates the growth of mildew. Results of tests conducted at these stations are accepted by the trade. However at least a year of exposure and preferably two years of exposure are required for meaningful results.

2. After completion of the work, it was found that mixing of the powder paint (4-43) is extremely critical and, if improperly handled, can lead to poor results. It may be advisable, therefore, to include this sample in any future test following the new mixing instructions which are sufficiently different to impact upon the performance of this coating.

3. Interior wall primers should be evaluated for their ability to prevent the bleed-through of water soluble stains. This property was not included in the tests conducted under this contract.

III INTRODUCTION

Air pollution is a serious threat to the health of our population. Although the problem is nationwide, it is most serious in heavily populated areas and especially so where climatic conditions prevent rapid dissipation of air pollutants. One such area is Metropolitan Los Angeles.

Architectural coatings are a significant source of air pollution, inasmuch as approximately one half of each gallon of paint, varnish, lacquer or related coating consists of volatile solvents which evaporate when the coating is applied. This is a relatively minor problem with water-base coatings, in which most of the solvent is water, but is serious with solvent-thinned coatings. The solvents emitted during application of the latter pollute the air in the immediate vicinity and eventually spread elsewhere.

California was foremost in the initiation of efforts and regulations to reduce the adverse effects of these solvents in their environment because of the serious problem in the Los Angeles area. The first result was Rule 66 which was quickly duplicated in the San Francisco Bay area. It has since spread to other states and was finally adopted in a modified form by the Environmental Protection Agency.

Rule 66, however, did not reduce solvent emission in architectural coatings. It only forced changes in solvent formulation to eliminate solvents which react rapidly with the ozone in the atmosphere to form eye-irritating compounds. Instead, other less reactive solvents were allowed. Thus the problem was not eliminated, but only made less serious.

During the recent past, the California Air Resources Board has taken steps, by developing the ARB Model Rule for Architectural Coatings, to actually reduce emissions of all volatile organic material to about half of the former amount, i.e., to a maximum of 250 grams per liter of applied coating.

Conformance to this ruling presented minimum difficulty for manufacturers of interior wall paints and exterior house paints, which account for approximately 50% of the total architectural coatings used, since most of these coatings are based on latex emulsions and thus contain less than 250 grams per liter of volatile organic material. However, exemptions had to be made for the 14 categories of these coatings, which are listed under the Objective below, and which account for the other 50% of these coatings.

Therefore, CARB wished to determine whether exempt commercial architectural coatings are now available, even from a limited number of suppliers, which can compete in performance with their conventional counterparts and thus enable CARB to remove these categories from the exempt list and, in doing so, achieve their ultimate goal of reducing volatile organic material of all architectural coatings to less than 250 grams per liter of paint, less water.

IV. OBJECTIVE

The purpose of this study was to obtain and evaluate the performance properties of commercially available high solids or water-based coatings, among the 14 classes now exempt from CARB's model rule for maximum content of organic material, in order to determine if these products are equivalent to the conventional (high solvent) coatings of the same type.

The exempt classes of coatings are as follows:

1. Unpigmented finishes, e.g., varnish, lacquer, shellac
2. Semi-transparent stains
3. Opaque stains for use on redwood, cedar, mahogany and fir
4. Primers, sealers and undercoaters
5. Wood preservatives (penetrating type)
6. Fire retardant coatings
7. Tile-like, high build glaze coatings
8. Waterproofing coatings except bituminous pavement sealers
9. Industrial maintenance topcoats
10. Metallic coatings
11. Swimming pool paints
12. Sign paints
13. Mastic coatings (15 mils minimum)
14. Multicolor paints

V. PROCEDURE

A. The plan followed during this investigation was to obtain CARB conforming paints and coatings and evaluate their properties vs equivalent conventional (solvent-thinned) coatings, preferably from the same suppliers.

However it was realized that the development of CARB conforming products was still in its infancy and that two problems would be encountered in doing so:

1. The technical difficulty (and cost) involved in developing equivalent CARB conforming coatings, especially with VOC levels below 250 g/l, of paint, less water.

2. The reticence among some manufacturers to participate in the program because they were concerned that CARB would circulate reports containing comparative data on their products.

Therefore, it was planned to cover as wide a territory as possible by:

1. Publicizing the program

2. Writing to a broad spectrum of paint manufacturers in order to make contact with any who might have products to offer.

B. Consequently, the following steps were taken:

1. A publicity release was sent to 23 industry publications and industry associations. See Appendix IA & IB.

2. Letters and questionnaires were sent to about 200 major paint manufacturers plus 164 companies in California requesting products which were commercial and could be purchased. See Appendix IIC & IID.

The results were limited, which was not too surprising considering the statements made in A above.

C. In order to encourage a better and broader response, letters and simplified test data forms were sent to about 70 raw material suppliers, to about 50 specialty paint manufacturers (wood preservatives, fire retardent paints, etc.) and to about 35 manufacturers who responded to the Publicity Release. Samples of test paints were requested directly from the supplier in order to encourage submission of products not yet commercial. See Appendix IIE, IIIF, IIIG. Also, VOC levels of up to about 350 g/l were accepted.

Thus, over 500 letters and questionnaires or test data forms were issued.

D. As a result of the publicity and survey, a total of 91 CARB conforming products and 57 equivalent conventional products were received and tested.

E. Samples were accepted for inclusion in this program until December 31, 1979 in order to allow sufficient time and funds to complete the test program. Products received since that date have not been tested and are not covered in this report.

Note: A list of samples received after December 31, 1979 is shown on page 6 above.

VI PRODUCTS TESTED

Upon examination of the samples and data submitted, it was realized that some of the exempt classes were broader than listed. Therefore, where necessary, they were broken down into sub-classes as shown below. Note also that the titles have been modified where necessary to coincide with actual practice. The number of samples tested are also included. Note that no samples were received for some classes or subclasses.

Class	Product	Samples CARB	Samples Conventional
1	Clear Finishes	11	8
1A	Interior Gloss	4	2
1B	Interior Semigloss(a)	4	3
1C	Exterior Gloss	2	2
1D	Exterior Semigloss(a)	1	1
2	Semi-transparent Stains	2	1
3	Opaque Stains	8	5
4	Primers, Sealers, Undercoaters	29	19
4A	Metal Primers		
4A-1	One Package	13	9
4A-2	Two Component	3	2
4A-Z	Zinc Rich	3	2
4B	Exterior Wood Primers	5	4
4C	Interior Wall Primers	5	2
4D	Enamel Undercoaters	None	
5	Wood Preservatives	None	
6	Fire Retardant Paints	None	
7	Tile-like Glaze Coatings	6	4
8	Waterproofing Coatings	7	3
9	Maintenance Topcoats	17	13
9A	Light Duty(b)	7	7
9B	One Package	6	4
9C	Two Component	4	2
10	Metallic Coatings	None	
11	Swimming Pool Paints	2	1
12	Graphic Arts Paints	None	
13	Mastic Coatings	8	2
13A	Waterproofing	6	2
13B	Texture	2*	
14	Multi-color Paints	1	1
14-->25		89 + 2*	57

* Not included due to absence of conventional controls

a - Clear semigloss finishes are pigmented with a flatting pigment, such as silica, which does not affect clarity.

b - Light duty maintenance paints are used for painting of equipment where service requirements are not severe.

The following data was supplied by the cooperators:

Class 1

CLEAR FINISHES

No.	Finish	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal.	Price ($/Gal) 5 Gals.	Date
1	IG	WB	382		28.00		9/79
2	IS	WB	362		28.00		9/79
3	EG	WB	275		28.00		9/79
4	ES	WB	274		28.00		9/79
5	IG	WB	369		ND		
6	IG	Conv	-		26.00		9/79
7	IS	Conv	-		26.00		9/79
8	EG	Conv	-		26.00		9/79
9	ES	Conv	-		26.00		9/79
10	IG	Conv	-		ND		
11	IS	WB		13	19.99	18.40	7/79
12	EG	WB	321		ND		
13	EG	Conv	-		24.00		3/80
14	IS	WB	222		17.99	17.74	8/79
15	IG	WB	237		17.99	17.74	8/79
16	IS	Conv	-		17.19	16.20	8/79
17	IS	WB		16	3.39/qt		5/80
18	IS	Conv	-		2.99/pt		5/80
19	IG	WB	ND		ND		

I	-	Interior	g/l	-	grams per liter
E	-	Exterior	%	-	% by volume
G	-	Gloss	Gal	-	Gallon
S	-	Semigloss	qt	-	quart
WB	-	Water base	pt	-	pint
Conv	-	Conventional	ND	-	No data

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 2			**SEMI-TRANSPARENT STAINS**				
1	All	WB	155	5.9	14.75		5/80
2	are	Conv	-		16.95		5/80
3	Brown	WB	86		11.99		5/80
Class 3			**OPAQUE STAINS**				
1	Brown	WB		3.2	9.50		5/79
3	White	WB	186	7.7	14.75		5/80
4	Brown	Conv	-		16.89		5/80
5	Red	WB	235		RMS		
6	White	WB	81		13.95		5/80
7	Brown	WB	72		13.95		5/80
8	White	Conv	-		15.45		5/80
9	Brown	Conv	-		15.45		5/80
10	Green	WB	124		12.30	11.80	8/79
11	Green	Conv	-		12.10	11.60	8/79
12	Brown	WB	214		10.99	10.89	8/79
13	Brown	Conv	-		11.99	11.89	8/79
14	Brown	WB	38		11.99		5/80

RMS - No price since product was submitted by raw material supplier.

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 4A			**METAL PRIMERS**				
1	Grey	WB	276		ND		
2	Brown	WB	283		ND		
4	Brown	WB	71	3	17.80	17.60	5/79
6	Grey	Conv	-		ND		
7	Brown	Conv	-		ND		
8	Brown	Conv	-		14.80	14.60	5/79
10	Grey	WB		2.2	5.50/qt		5/79
13	Brown	WB	312		ND		
14	Brown	Conv	-		ND		
17	White	Conv	-		3.75-4.50/qt		5/79

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 4A (Cont)			METAL PRIMERS				
20	Brown	HS	238		ND		
21	Brown	Conv	-		11.10	10.60	7/79
23	Orange	HS	243			14.50	8/79
24	Brown	HS	180			13.00	8/79
26	Orange	Conv	-			13.50	8/79
27	Brown	Conv	-			10.00	8/79
28	Brown	Conv-2	-			13.00	8/79
29	White	WB-2	116			16.00	8/79
30	Grey	WB-3Z	61			26.00	8/79
31	Green	Conv-3Z	-			26.00	8/79
32	White	WB	88			12.00	8/79
33	Grey	WB-2Z	0			32.00	8/79
34	Grey	Conv-2Z	-			28.00	8/79
35	Grey	HS-2Z	135	17		24.00	8/79
36	Brown	WB	248		ND		
37	Brown	Conv	-		ND		
39	Red	HS-2	213		25.00		5/80
40	Red	Conv-2	-		17.60		5/80
42	White	WB	44		RMS		
43	White	Powder	0		ND		
49	Green	HS	0		ND		
51	White	WB	77	3.1	13.00		5/80

HS - High solids
2 - 2 component
3 - 3 component
Z - Zinc rich paint

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 4B			EXTERIOR WOOD PRIMERS				
3	All	WB	111	6.1	18.95		5/80
5	are	WB	114	4.2	13-15		5/79
9	White	Conv	-		12-14		5/79
11		WB		3.8	12.00		5/79
15		Conv	-		11-14		5/79
18		Conv	-		19.95		5/80
41		WB	141		10.00		8/79
44		WB	38		10.99		5/80
47		Conv	-		12.99		5/80
Class 4C			INTERIOR WALL PRIMERS				
12	All	WB		7.2	9.50		5/79
16	are	Conv	-		ND		
19	White	WB	78	2.3	RMS		
22		WB	143		10.50		8/79
25		WB	141		8.00		8/79
45		WB	36		8.00		5/80
46		Conv	-		9.99		5/80
Class 7			TILE-LIKE GLAZE COATINGS				
1	White	SF-2	0		35.95	30.00	5/79
2	Brown	SF-2	0		35.55	33.05	5/79
5	White	HS-2	353		ND		
6	White	HS-2	87		25.00		7/79
9	White	Conv	-		25.45		5/80
10	White	Conv	-		35.60		5/80
11	White	Conv	-		20.00		7/79
12	White	WB-2	235		23.00		5/80
15	White	Conv	-		25-30		5/79
16	Brown	HS-2	0		32	28	6/79

SF - Solvent free

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 8			**WATERPROOFING COATINGS**				
3	Clear	WB	0		13.75	12.25	8/79
4	Clear	WB	0		14.95	14.95	8/79
6	White	WB	182		RMS		
7	White	Conv	-		RMS		
8	White	WB	0		18-20		10/79
11	Clear	Conv	-		25-30		5/79
12	Clear	Conv	-		25-30		5/79
13	Grey	WB	0		4.40	4.10	9/79
14	Black	WB	0		2.75	2.45	9/79
15	Black	WB	0		3.00		3/80
Class 9			**MAINTENANCE TOPCOATS**				
1	Red	WB	178		ND		
2	Blue	WB	168		ND		
3	White	WB	225		ND		
4	White	WB	242	11	18.80	18.60	5/79
5	White	WB	186	8.7	16.00		5/79
6	Red	Conv	-		16.00		5/79
7	Blue	Conv	-		ND		
8	White	Conv	-		ND		
9	White	Conv	-		18.20	18.00	5/79
10	White	Conv	-		12.00		5/79
11	White	WB	334		ND		
12	White	Conv	-		ND		
13	Grey	WB	346		ND		
14	Grey	Conv	-		ND		
15	White	WB	253		29.39		5/80
16	White	Conv	-		23.89		5/80
17	White	HS	229		ND		
18	White	Conv	-		11.70	11.20	7/79
19	White	HS-2	120		20.00		8/79
20	White	WB-2	106		16.00		8/79

No.	Color	Type	VOC g/l	VOC %	Price ($/Gal) 1 Gal	Price ($/Gal) 5 Gals	Date
Class 9 (Cont)			MAINTENANCE TOPCOATS				
21	White	Conv-2	-		15.00		8/79
22	White	HS-2	213		25.00		5/80
23	White	Conv-2	-		17.65		5/80
24	White	WB-2	117	12.9	RMS		
25	Grey	HS	0		ND		
26	White	WB	243		RMS		
27	White	WB	278	16.3	22.95		5/80
28	Red	WB	217	9.7	7.35/qt		5/80
29	White	Conv	-		18.95		5/80
30	Red	Conv	-		23.75		5/80
Class 12			SWIMMING POOL PAINTS				
1	All	WB	320		22.95		5/80
2	are	Conv	-		23.75		5/80
3	White	WB		3	18.95		5/80
Class 13			MASTIC COATINGS				
3	White	WB	27		16	16	5/79
4	White	WB	31		13.80	13.80	6/79
6	White	HS-2		5	ND		
8	Black	Conv	-		ND		
9	White	Conv	-		17.00		10/79
10	White	WB	0		15.10		10/79
12	Black	WB	0		16.00		10/79
13	Black	WB	0		16.00		10/79
Class 14			MULITICOLOR PAINTS				
1		WB		0.5	17.00		9/79
2		Conv	-		15.00		9/79

VII TEST RESULTS

Tests were chosen which would rapidly differentiate between CARB conforming and equivalent conventional paints.

The test data are too bulky (27 pages) to include in the body of the report. Therefore, they have been placed in Appendix II. See Section IX "Glossary" for a description of the properties tested, Section X "Code and Abbreviations" for an explanation of the terms used and the Test Procedure (Appendix III) for the test methods used.

Inasmuch as some tests are subjective, the observations made have been scored using the following ASTM Scoring Scheme.

Score	Performance	or	Effect
10	Perfect		None
9	Excellent		Trace
8	Very good		Very slight
6	Good		Slight
4	Fair		Moderate
2	Poor		Severe
0	No value		Failed

The use of this numerical scheme avoids the necessity of inserting verbal descriptions in the Test Data tables.

VIII DISCUSSION OF RESULTS

The test results can best be rated, compared and analyzed by assigning the following values to the results obtained or observations made:

10 = Decidedly above average for the group
7 = Significantly above average
5 = Average or equivalent
3 = Significantly below average
0 = Decidedly below average for the group

These values are shown in Tables 1 thru 21 below. Note that, for some classes, both CARB conforming and conventional paints are included even though separate tables may be used in the Test Data because of space limitations. Also note that no attempt has been made to weight any property since neither consumers nor manufacturers agree as to the relative importance of any property or group of properties.

The following classes are rated in the tables below:

Table	Class	Product	CARB	Conventional
1	1A	Clear Interior Gloss Finishes	X	X
2	1B	Clear Interior Semigloss Finishes	X	X
3	1C	Clear Exterior Gloss Finishes	X	X
4	1D	Clear Exterior Semigloss Finishes	X	X
5	2	Semi-transparent Stains	X	X
6	6	Opaque Stains	X	X
7	4A-1	Metal Primers - One Package	X	
8	4A-1	Ditto		X
9	4A-2	Metal Primers - Two Component	X	X
10	4A-Z	Metal Primers - Zinc Rich	X	X
11	4B	Exterior Wood Primers	X	X
12	4C	Interior Wall Primers	X	X
13	7	Tile-like Glaze Coatings	X	X
14	8	Waterproofing Coatings	X	X

Table	Class	Product	CARB	Conventional
15	9A	Maintenance Topcoats - Light Duty	X	
16	9A	Ditto		X
17	9B	Maintenance Topcoats - One Package	X	X
18	9C	Maintenance Topcoats - 2 Component	X	X
19	11	Swimming Pool Paints	X	X
20	13A	Mastic Coatings - Waterproofing	X	X
21	14	Multicolor Paints	X	X

The following classes and sub-classes are not included since no samples were received:

Class 4D	Enamel Undercoaters
Class 5	Wood Preservatives
Class 6	Fire Retardant Paints
Class 10	Metallic Paints
Class 12	Graphic Arts Paints
Class 13B	Texture Paints (no conventional paints)

Table 1

Class 1A CLEAR INTERIOR GLOSS FINISHES

	CARB				Conventional	
From -----→	1 (15)	5 (33)	15 (8)	19 (15)	6 (15)	10 (33)
Type -----→	WB	WB	WB	WB		
Viscosity(a)		High	Low			
Stability(b)	5	3	7	5	7	5
Drying						
Open time(c)	5	5	5	5	5	7
Dry(d)	7	3	7	5	7	3
Application	5	5	5	5	5	5
Gloss(e)	5	5	7	7	5	5
Adhesion	5	5	5	5	5	5
Flexibility	5	5	5	5	5	5
Abrasion Resistance	7	3	5	5	7	5
Alcohol Resistance	0	5	5	7	5	5
Solvent Resistance	0	3	5	0	7	10
Cleaner Resistance(f)	5	5	3	5	5	3
Hot Water Resistance	5	5	5	5	5	5
Cold Water Resistance	5	5	5	5	5	5
Special Sealer Required	0	5	5	5	5	5

WB - Water base

a - Viscosity is not rated since any properties affected by viscosity, e.g., Application, are rated elsewhere in the table.

b - Includes Viscosity and Storage Stability.

c - Set to touch in the Test Data is an indication of the time available to apply the coating. This is of special importance when painting outdoors.

d - Dry is a summation of Tack Free, Dry Hard and Dry Thru in the Test Data

e - Gloss is not rated since consumers differ as to the level desired.

f - Cleaners usually contains solvents such as Mineral Spirits.

Table 2

Class 1B CLEAR INTERIOR SEMIGLOSS FINISHES

	CARB				Conventional		
	2 (15) WB	11 (8) WB	14 (8) WB	17 (9) WB	7 (15)	16 (8)	18 (9)
Viscosity		High	Low				Low
Stability	5	3	7	5	5	5	7
Drying							
Open time	5	3	5	5	5	7	3
Dry	7	10	5	5	5	5	3
Application	5	5	5	5	5	5	5
Gloss		High		Low			
Adhesion	5	5	5	5	5	5	5
Flexibility	5	3	5	5	5	5	5
Abrasion Resistance	5	7	10	5	10	3	5
Alcohol Resistance	3	3	3	7	7	7	7
Solvent Resistance	5	5	3	3	7	0	7
Cleaner Resistance	5	5	5	5	5	5	5
Hot Water Resistance	7	7	5	7	5	5	7
Cold Water Resistance	0	7	5	5	5	7	3
Special Sealer Required	0	5	5	5	5	5	5

Table 3

Class 1C CLEAR EXTERIOR GLOSS FINISHES

	CARB		Conventional	
From -----→	3 (15)	12 (20)	8 (15)	13 (20)
Type -----→	WB	WB		
Viscosity		Low		
Stability	3	5	5	5
Drying				
Open time	5	5	7	3
Dry	3	7	5	7
Application	5	5	5	5
Gloss	5	7	5	3
Adhesion	5	5	5	5
Flexibility	5	0	5	5
Abrasion Resistance	5	5	10	3
Acc. Weathering	7	5	7	0
Special Sealer Required	0	5	5	5

Table 4

Class 1D

CLEAR EXTERIOR SEMIGLOSS FINISHES

From -----→	CARB 4 (15)	Conv. 9 (15)
Type -----→	WB	
Viscosity	Equal	Equal
Stability	3	7
Drying		
Open time	3	7
Dry	5	5
Gloss		High
Application	5	5
Adhesion	5	5
Flexibility	5	5
Abrasion Resistance	5	5
Acc. Weathering	7	3
Special Sealer Required	3	7

Table 5

Class 2 SEMI-TRANSPARENT STAINS

	CARB		Conv.
	1	3	2
Color -----→	Brown	Brown	Brown
From -----→	(21)	(9)	(21)
Type -----→	WB	WB	
Viscosity		High	Low
Stability	7	5	5
Drying			
Open time	5	5	0
Dry	5	7	3
Application	5	5	5
Opacity	5	5	7*
Water Repellancy	3	5	7
Acc. Weathering	5	7	5

* Semi-transparent stains are supposed to have low opacity

Table 6

Class 3

OPAQUE STAINS

	CARB								Conventional				
	1	3	5	6	7	10	12	14	4	8	9	11	13
Color ----→	Bwn	Wht	Red	Wht	Bwn	Grn	Bwn	(Bwn)	Bwn	Wht	Bwn	Grn	Bwn
From ----→	(13)	(21)	(35)	(25)	(25)	(29)	(32)	(9)	(15)	(25)	(25)	(29)	(32)
Type ----→	WB	WB	WB	WB	WB	WB	WB	WB					
Viscosity	Low						High					Low	
Stability	5	5	5	5	5	7	10	10	0	3	3	5	7
Drying													
Open time	5	3	5	5	5	5	5	5	5	0	3	3	3
Dry	7	7	7	7	7	7	7	10	5	0	3	0	5
Application	5	5	5	5	5	5	5	5	5	5	5	5	5
Opacity	7	3*	7	5	5	5	7	7	7	5	7	5	7
Water Repellancy	5	7	0	3	7	3	7	5	5	10	7	7	10
Acc. Weathering	5	5	5	5	5	5	5	7	5	5	5	5	5

* Tint Base

Bwn - Brown
Wht - White
Grn - Green

Table 7

Class 4A-1

METAL PRIMERS

One Package CARB

	1	2	4	10	13	20	23	24	32	36	42	49	51
Color ----→	Gry	Bwn	Bwn	Gry	Bwn	Bwn	Org	Bwn	Wht	Bwn	Wht	Grn	Wht
From -----→	(23)	(23)	(31)	(13)	(33)	(11)	(22)	(22)	(22)	(20)	(26)	(34)	(14)
Type -----→	WB	WB	WB	WB	WB	HS	HS	HS	WB	WB	WB	HS	WB
Viscosity		Low	High				High		High	VH			
Stability	3	0	5	7	0	3	5	5	0	0	7	7	7
Drying													
Open time	5	5	5	5	7	0	5	3	5	3	5	0	5
Dry	7	7	10	10	7	3	0	0	10	5	3	0	7
Application	5	5	5	5	5	5	5	5	5	5	5	5	5
Opacity	5	5	5	5	5	5	3	5	3	5	3	5	3
Adhesion	5	5	5	5	5	3	5	3	5	5	5	5	5
Enamel Holdout	10	7	3	10	10	5	5	7	10	5	7	3	0
Corrosion Resist.	0	0	0	0	7	3	10	3	0	5	5	7	0
Acc. Weathering	5	7	7	7	5	7	0	5	7	10	5	5	7

Org - Orange
HS - High Solids
VH - Very High

Table 8

Class 4A-1 — METAL PRIMERS — One Package Conventional

Color ---→ / From ---→	6 Gry (23)	7 Bwn (23)	8 Bwn (31)	14 Bwn (33)	17 Wht (13)	21 Bwn (11)	26 Org (22)	27 Bwn (22)	37 Bwn (20)
Viscosity - Mixed			Low						Low
Stability	5	3	5	5	3	3	3	3	3
Drying									
Open time	7	7	7	7	5	5	5	3	7
Dry	5	5	3	5	10	7	.3	0	3
Application	5	5	5	5	5	5	5	5	5
Opacity	5	5	5	5	3	5	3	5	5
Adhesion	5	5	5	5	5	5	5	5	5
Enamel Holdout	7	7	5	7	7	3	5	7	7
Corrosion Resistance	3	0	5	10	0	3	3	0	5
Acc. Weathering	5	3	5	5	5	7	0	5	7

Table 9

Class 4A-2 — METAL PRIMERS — 2 Component

	CARB			Conventional	
	29	39	43	28	40
Color ----→	Wht	Red	Wht	Bwn	Red
From ----→	(22)	(28)	(10)	(22)	(28)
Type ----→	WB	HS	Pow		
Viscosity - Mixed					Low
Stability	0	0	10	3	5
Pot Life	7	5	0	5	7
Drying					
Open time	5	7	3	5	5
Dry	5	3	?	5	7
Application	5	5	3	5	5
Opacity	3	5	5	5	5
Adhesion	5	5	3	5	5
Enamel Holdout	3	5	0	7	5
Corrosion Resistance	0	7	3	3	7
Accelerated Weathering	0	5	3	7	5

Pow - Powder

? - Could not be determined

Table 10

Class 4A-Z	METAL PRIMERS			Zinc-Rich	
	CARB			Conventional	
	30	33	35	31	34
Color -----→	Grey	Grey	Grey	Green	Grey
From -----→	(22)	(22)	(22)	(22)	(22)
Type -----→	WB	WB	HS		
Viscosity - Mixed	High			Low	Low
Stability	7	5	5	7	0
Pot Life	5	5	5	5	0
Drying					
Open time	5	3	3	7	3
Dry	5	10	0	5	10
Application	5	5	5	5	5
Opacity	5	5	5	5	5
Adhesion	5	5	5	5	5
Enamel Holdout	5	3	7	5	5
Corrosion Resistance	0	5	0	5	5
Accelerated Weathering	5	5	3	3	5

Table 11

Class 4B

EXTERIOR WOOD PRIMERS

	CARB					Conventional			
	3	5	11	41	44	9	15	18	47
Color ------→	Wht	Wht	Wht	Wht	Wht	Wht	Wht	Wht	Wht
From -------→	(21)	(36)	(13)	(22)	(9)	(36)	(13)	(21)	(9)
Type -------→	WB	WB	WB	WB	WB				
Viscosity			Low	High				High	Low
Stability	5	7	5	5	7	5	5	3	10
Drying									
Open time	3	5	5	5	3	7	5	7	7
Dry	10	7	10	7	10	5	3	3	0
Application	5	5	5	5	5	5	5	5	5
Opacity	5	7	5	7	3	5	5	5	3
Adhesion	5	5	5	5	5	5	5	5	5
Bleeding	5	3	7	5	3	7	5	5	7
Enamel Holdout	7	5	5	7	3	7	7	7	3
Accelerated Weathering	7	0	10	3	7	3	7	0	0

Table 12

Class 4C

INTERIOR WALL PRIMERS

	CARB					Conventional	
	12	19	22	25	45	16	46
Color ------>	Wht	Wht	Wht	Wht	Wht	Wht	Wht
From ------>	(13)	(7)	(4)	(22)	(9)	(13)	(9)
Type ------>	WB	WB	WB	WB	WB		
Viscosity				Low		High	
Stability	3	5	5	5	5	3	5
Drying							
Open time	5	5	5	5	5	7	5
Dry	5	7	5	5	7	5	5
Application	5	5	5	5	5	5	5
Opacity	5	5	5	5	5	5	3
Adhesion	5	5	5	5	5	5	5
Enamel Holdout	7	5	7	3	5	5	3

Table 13

Class 7

TILE-LIKE GLAZE COATINGS

	CARB						Conventional			
	1	2	5	6	12	16	9	10	11	15
Color ------→	Wht	Bwn	Wht	Wht	Wht	Bwn	Wht	Wht	Wht	Wht
From -------→	(1)	(1)	(16)	(21)	(16)	(5)	(16)	(16)	(21)	(1)
Type -------→	SF-2	SF-2	HS-2	HS-2	WB-2	HS-2				
Viscosity - Mixed		H	Low	VH	H	H	Low		H	
Stability	3	7	5	5	3	10	5	0	7	7
Pot Life	0	3	3	5	10	3	5	5	5	7
Drying										
Open time	3	3	3	3	5	3	5	3	3	7
Dry	5	5	5	5	3	5	10	3	5	10
Application	5	5	5	3	5	7	5	7	5	7
Gloss	Low	VH			VL	H			H	
Adhesion	5	5	5	5	5	5	5	3	5	5
Flexibility	0	0	5	5	5	0	5	5	5	5
Abrasion Resistance	3	5	7	7	5	5	5	5	10	5
Water Resistance	5	5	5	5	0	5	0	5	5	5
Gloss Retention	3	3	7	7	7	3	3	7	3	7
Color Retention	3	5	7	3	3	7	3	7	3	3

SF - Solvent free
HS - High solids
2 - 2 component
H - High
VH - Very high
VL - Very low

Table 14

Class 8

WATERPROOFING COATINGS

	CARB							Conventional		
	3	4	6	8	13	14	15	7	11	12
Color ------→	Clr	Clr	Wht	Wht	Gry	Blk	Blk	Wht	Clr	Clr
From -------→	(24)	(24)	(17)	(12)	(3)	(3)	(20)	(17)	(1)	(1)
Type -------→	WB	WB	WB	WB	WB	WB	WB			
Viscosity	VL	VL			VH		H	H	VL	VL
Stability	0	0	3	0	0	5	5	5	10	10
Drying										
Open time	5	5	3	3	0	5	5	3	3	10
Dry	10	7	10	10	5	0	0	7	3	7
Application	5	5	5	5	3	5	5	5	5	5
Adhesion	5	5	5	5	5	5	5	5	5	5
Opacity*	Clr	Clr	*	*	*	Blk	Blk	*	Clr	Clr
Water Repellancy	3	3	7	5	5	7	7	10	3	10
Water Resistance	10	10	7	5	3	0	3	7	10	7
Acc. Weathering	10	0	7	10	7	5	10	3	5	7

* Not rated since Clears have no opacity and Blacks have complete opacity.

Table 15

Class 9A — MAINTENANCE TOPCOATS — Light Duty CARB

	1	2	3	4	15	27	28
Color ----→	Red	Blue	Wht	Wht	Wht	Wht	Red
From ----→	(23)	(23)	(23)	(31)	(36)	(21)	(21)
Type ----→	WB	WB	WB	WB	WB	WB	WB
Viscosity		Low	High		VL		VL
Stability	3	7	0	7	5	7	0
Drying							
Open time	5	5	5	5	3	3	3
Dry	3	7	7	7	7	7	7
Application	5	5	3	5	5	5	5
Opacity	5	3	7	7	5	7	3
Gloss	Low		VL	VL			
Adhesion	3	5	5	5	5	5	3
Flexibility	5	5	5	5	5	5	5
Acc. Weathering	7	5	7	7	7	7	0

Table 16

Class 9A — MAINTENANCE TOPCOATS — Light Duty Conventional

Color ------> / From ------>	6 Red (23)	7 Blue (23)	8 Wht (23)	9 Wht (31)	16 Wht (15)	29 Wht (21)	30 Red (21)
Viscosity		Low		Low			
Stability	5	7	7	7	0	3	3
Drying							
Open time	7	7	7	7	7	7	7
Dry	5	5	5	7	7	5	5
Application	5	5	5	5	5	5	5
Opacity	10	10	7	7	10	5	0
Gloss	High		High				
Adhesion	5	5	5	5	5	5	5
Flexibility	5	5	5	5	5	5	5
Acc. Weathering	3	3	3	3	3	5	3

Table 17

Class 9B

MAINTENANCE TOPCOATS

One Package

	CARB						Conventional			
	5	11	13	17	25	26	10	12	14	18
Color ----→	Wht	Wht	Gry	Wht	Gry	Wht	Wht	Wht	Gry	Wht
From ----→	(36)	(33)	(33)	(11)	(34)	(30)	(36)	(33)	(33)	(11)
Type ----→	WB	WB	WB	HS	HS	WB				
Viscosity			Low		High		Low		Low	VH
Stability	5	3	0	3	5	7	3	5	7	5
Drying - Open time	5	5	5	3	3	3	7	5	5	7
- Dry	7	3	10	5	0	10	5	7	10	5
Application	5	5	5	5	5	5	5	5	5	5
Opacity	7	5	7	5	7	5	3	5	7	5
Gloss	Low	High	High		VL	Low	High	VH	High	High
Adhesion	5	5	5	5	3	5	3	5	5	3
Flexibility	5	5	5	5	5	5	5	5	5	5
Resistance To-										
Abrasion	10	3	3	0	7	7	7	7	3	3
Water	5	3	7	5	0	10	5	5	7	0
Xylol	10	0	3	0	0	0	0	0	3	0
Cleaner	5	3	3	7	0	10	3	3	7	7
Alcohol	0	3	3	0	3	10	0	0	3	0
Acid	0	3	3	10	10	0	7	3	3	5
Corrosion	0	3	10	7	10	7	3	3	X	5
Acc. Weathering	10	7	3	7	7	10	5	7	X	5

X - Not tested

Table 18

Class 9C	MAINTENANCE TOPCOATS				2 Component	
	CARB				Conventional	
	19	20	22	24	21	23
Color ----→	Wht	Bge	Wht	Wht	Bge	Wht
From ----→	(22)	(22)	(28)	(18)	(22)	(28)
Type ----→	HS	WB	HS	WB		
Viscosity		High				Low
Stability	3	3	7	5	5	7
Pot Life	5	3	5	7	5	7
Drying - Open time	3	5	7	3	5	5
- Dry	3	7	5	3	7	10
Application	5	5	5	5	5	5
Opacity	5	7	5	3	5	3
Gloss	High	VL	Low		VL	VL
Adhesion	5	5	5	5	5	5
Flexibility	5	5	3	5	5	5
Resistance To-						
Abrasion	3	3	10	5	3	5
Water	7	0	7	0	7	5
Xylol	0	5	0	5	5	5
Cleaner	5	5	3	5	5	5
Alcohol	0	7	0	0	7	7
Acid	10	0	3	0	3	0
Alkali	5	5	5	5	5	5
Corrosion	5	0	5	0	5	5
Acc. Weathering	3	5	7	3	5	5

Bge - Beige

Table 19

Class 11 — SWIMMING POOL PAINTS

	CARB 1	CARB 3	Conv. 2
Color ----→	White	White	White
From ----→	(20)	(27)	(20)
Type ----→	WB	WB	
Viscosity	High		Low
Stability	3	5	5
Drying			
Open time	5	5	5
Dry	5	5	5
Application	5	5	5
Opacity	5	5	5
Adhesion	5	5	3
Water Resistance	5	5	5
Sod. Hypochlorite Resist.	5	5	5
Accelerated Weathering	5	3	5

Table 20

Class 13A

MASTIC COATINGS - WATERPROOFING

	CARB						Conv	
	3	4	6	10	12	13	8	9
Color ------→	Wht	Wht	Wht	Wht	Blk	Blk	Blk	Wht
From -------→	(6)	(6)	(22)	(12)	(12)	(12)	(20)	(12)
Type -------→	WB	WB	HS-2	WB	WB	WB		
Viscosity	H		VH	Low	Low	H	VH	H
Stability	5	5	7	0	3	7	10	0
Drying								
Open time	3	3	3	5	5	5	3	7
Dry	0	0	5	10	5	5	0	10
Application	5	5	3	7	7	7	3	7
Adhesion	5	5	5	5	5	5	5	5
Opacity	5	5	5	5	5	5	5	5
Water Repellancy	5	7	10	5	3	3	10	7
Water Resistance	0	0	3	5	5	5	3	5
Acc. Weathering	5	5	3	7	7	5	3	7

Table 21

Class 14 MULTICOLOR PAINTS

From -------->	CARB 1 (2)	Conv. 2 (37)
Viscosity	Same	Same
Stability	7	0
Drying		
Open time	5	5
Dry	5	5
Application	5	5
Pattern (Appearance)	3	7
Opacity	3	7
Gloss	Equal	Equal
Adhesion	7	3
Flexibility	5	5

The CARB conforming products compared with the equivalent conventional coatings as shown below.

Note that, in order to determine the potential of the CARB coatings to be competitive with the equivalent conventional coatings, the following descriptive relationships have been used to summarize the ratings in Tables 1 thru 21 above.

Inadequate - Rating of 5 but lower than the conventional paints.

Marginal - Rating of 3 but either equal to or superior to the poorest of the conventional paints.

Inferior - Rating of 3 and lower than the conventional paints.

Poor - Rating of 0.

Class 1A Clear Interior Gloss Finishes — Table 1

None of the four CARB conforming products tested were competitive to the conventional finishes but one was marginal (1-15).

1-1 Poor alcohol resistance
Poor solvent resistance
Requires a special sealer

1-5 Inferior package stability
Slightly slow dry
Inferior abrasion resistance
Inferior solvent resistance

1-15 Inadequate solvent resistance
Marginal cleaner resistance

1-19 Poor solvent resistance

Class 1B Clear Interior Semigloss Finishes — Table 2

Only one of the four CARB conforming products tested was competitive (1-17).

1-2 Inferior alcohol resistance
Poor cold water resistance
Requires a special sealer

1-11 Inferior package stability
Short open time
Inferior flexibility
Inferior alcohol resistance

1-14 Inferior alcohol resistance
Marginal solvent resistance

1-17 Marginal solvent resistance

Class 1C Clear Exterior Gloss Finishes — Table 3

Neither of the two CARB conforming products tested was competitive.

1-3 Inferior package stability
Slightly slow dry
Special sealer required

1-12 Poor flexibility

Class 1D Clear Exterior Semigloss Finishes — Table 4

The one CARB conforming product tested was not competitive.

1-4 Inferior package stability
Slightly fast dry
Special sealer required

Class 2 Semi-transparent Stains — Table 5

Neither of the two CARB conforming stains tested was competitive.

2-1 Inadequate transparency
Inferior water repellancy

2-3 Inadequate transparency
Inadequate water repellancy

Class 3 Opaque Stains — Table 6

Four of the eight CARB conforming stains tested were competitive (3-1, 3-7, 3-12, 3-14) and one (3-3) was marginal.

3-1 No defects

3-3 Short open time
Low opacity as a tint base but should be satisfactory if tinted

3-5 Poor water repellancy

3-6 Inferior water repellancy

3-7 No defects

3-10 Inferior water repellancy

3-12 No defects

3-14 No defects

Class 4A-1 Metal Primers - One Package — Tables 7 and 8

Of the thirteen CARB conforming products tested, only one (4-42) was competitive.

4-1 Marginal package stability
Poor corrosion resistance

4-2 Poor package stability
Poor corrosion resistance

4-4 Marginal enamel holdout
Poor corrosion resistance

4-10 Poor corrosion resistance

4-13 Poor package stability

4-20 Marginal package stability
Very long open time
Slightly slow dry
Inferior adhesion
Marginal corrosion resistance

4-23 Very slow dry
Marginal opacity
Poor weathering

4-24 Long open time
Very slow dry
Inferior adhesion
Marginal corrosion resistance

4-32 Poor package stability
Marginal opacity
Poor corrosion resistance

4-36 Poor package stability
Short open time

4-42 Slightly long dry
Marginal opacity

4-49 Very long open time
Very slow dry
Marginal enamel holdout

4-51 Marginal opacity
Poor enamel holdout
Poor corrosion resistance

Class 4A-2 Metal Primers - 2 Component Table 9

None of the three CARB conforming primers tested was competitive

4-29 Poor package stability
Inferior opacity
Inferior enamel holdout
Poor corrosion resistance
Poor weathering

4-39 Poor package stability
Slightly slow dry

4-43 Very short pot life
This is a powder which requires special precautions to obtain optimum cure. Otherwise produces a powdery surface. The coating evaluated was not an effective metal primer.

Class 4A-Z Metal Primers - Zinc Rich Table 10

One of the three CARB conforming products tested was marginal (4-33).

4-30 Poor corrosion resistance

4-33 Short open time
Inferior enamel holdout (not uncommon for zinc-rich primers)

4-35 Long open time
Very slow dry
Poor corrosion resistance
Inferior weathering

Class 4B Exterior Wood Primers Table 11

Three of the five CARB conforming primers tested were competitive (4-3, 4-11, 4-41).

4-3 Slightly short open time

4-5 Slightly more bleeding
Poor weathering

4-11 No defects

4-41 Marginal weathering (primers are intended to be topcoated)

4-44 Short open time
Marginal opacity
Slightly more bleeding
Marginal enamel holdout

Class 4C Interior Wall Primers Table 12

All of the five CARB conforming primers tested were competitive.

4-12 Marginal package stability

4-19 No defects

4-22 No defects

4-25 Marginal enamel holdout

4-45 No defects

Class 7 Tile-like Glaze Coatings

Table 13

Two of the six CARB coatings tested were marginal (7-5, 7-6).

7-1 Marginal package stability
Very short pot life
Long open time
Poor flexibility
Inferior abrasion resistance
Marginal gloss retention
Marginal color retention

7-2 Short pot life
Long open time
Poor flexibility
Marginal gloss retention

7-5 Short pot life
Long open time

7-6 Long open time
Slightly hard application
Marginal color retention

7-12 Marginal package stability
Slightly slow dry
Inferior water resistance
Marginal color retention

7-16 Short pot life
Long open time
Poor flexibility

Class 8 Waterproofing Coatings

Table 14

One of the seven CARB coatings tested was marginal (8-6).

8-3 Poor package stability
Marginal water repellancy

8-4 Poor package stability
Marginal water repellance
Poor weathering

8-6 Inferior package stability
Slight short open time

8-8 Poor package stability
Slightly short open time
Inadequate water resistance

8-13 Poor package stability
Very long open time
Difficult to apply
Inferior water resistance

8-14 Very slow dry
Inferior water resistance

8-15 Very slow dry
Inferior water resistance

Class 9A Maintenance Topcoats - Light Duty Tables 15 & 16

Four of the seven CARB conforming topcoats tested were competitive (9-2, 9-4, 9-15, 9-27).

9-1 Marginal package stability
Slow dry
Inferior adhesion

9-2 Marginal opacity

9-3 Poor package stability
Slightly difficult to apply

9-4 No defects

9-15 Short open time

9-27 Short open time

9-28 Poor package stability
Short open time
Marginal opacity
Inferior adhesion
Poor weathering

Class 9B Maintenance Topcoats - One Package Table 17

None of the six CARB conforming paints tested were competitive.

9-5 Poor resistance to
Alcohol
Acid
Corrosion

9-11 Marginal package stability
Slightly slow dry
Marginal resistance to
Abrasion
Water
Xylol
Cleaners
Acid
Corrosion

9-13 Poor package stability
Marginal resistance to
Abrasion
Cleaners
Acid

9-17 Marginal package stability
Long open time
Poor resistance to
Abrasion
Xylol
Alcohol

9-25 Long open time
Very slow dry
Marginal adhesion
Poor resistance to
Water
Xylol
Cleaners

9-26 Short open time
Poor resistance to
Xylol
Acid

Class 9C Maintenance Topcoats - 2 Component Table 18

None of the four CARB conforming paints tested was competitive.

9-19 Inferior package stability
Long open time
Slightly slow dry
Marginal abrasion resistance
Poor xylol resistance
Poor alcohol resistance
Inferior weathering

9-20 Inferior package stability
Short pot life
Marginal abrasion resistance
Poor resistance to
Water
Acid
Corrosion

9-22 Inferior flexibility
Poor xylol resistance
Inferior cleaner resistance
Poor alcohol resistance

9-24 Short open time
Slightly slow dry
Marginal opacity
Poor resistance to
Water
Alcohol
Acid
Corrosion
Inferior weathering

Class 11 Swimming Pool Paints — Table 19

One of the two CARB conforming paints tested was marginal (11-1).

11-1 Inferior package stability

11-3 Inferior weathering

Class 13A Mastic Coatings - Waterproofing — Table 20

None of the six CARB conforming paints tested was competitive.

13-3 Long open time
Very slow dry
Inadequate water repellancy
Poor water resistance

13-4 Long open time
Very slow dry
Poor water resistance

13-6 Long open time
Difficult to apply
Marginal water resistance
Marginal weathering

13-10 Poor package stability
Inferior water repellancy

13-12 Marginal package stability
Poor water repellancy

13-13 Poor water repellancy

Class 14 Multicolor Paints — Table 21

The one CARB conforming product tested was not competitive.

14-1 Inferior appearance
Inferior opacity

IX GLOSSARY

A simple description of the properties tested will aid in understanding the test data:

Viscosity - Fluidity

Viscosity Stability - Retention of viscosity during storage. Four weeks of accelerated storage is considered to be as severe as 6 months of normal storage.

Storage Stability - Absence of separation, skinning and pigment settling during storage, and the relative ease of remixing the paint after storage.

Pot Life - Multicomponent paints tend to react as soon as mixed. However, this reaction should be controlled so that the mixed paint is useable for at least a working day, i.e., 6 to 8 hours.

Drying Time -

Set to touch - A measure of the "open" or working time during which the paint can be easily brushed.

Tack Free - Free of any tackiness. Coating can be handled carefully.

Dry hard - Coating is resistant to normal handling.

Dry thru - Coating is hard and can be handled readily. It can be placed in service except for extreme conditions which require a 7 day dry.

Application Ease - The ability to apply the coating without excessive drag.

Gloss - Shininess or lustre

Opacity - Ability of the coating to hide or obscure the surface onto which it is applied.

Enamel Holdout - A measure of the porosity of the primer. A nonporous primer will not adversely affect the gloss of the topcoat applied over it.

Bleeding - Cedar and redwood contain soluble tanins which tend to bleed through and discolor the applied paint. One purpose of a primer is to prevent bleeding so that the house paint applied over it will not be discolored.

Appearance - Multicolor paints are applied to produce a specific and recognizable pattern with a distinct definition.

Adhesion - Ability to adhere to the substrate. The performance of a coating will deteriorate rapidly if its adhesion is poor.

Flexibility - Since exposed steel expands and contracts with changes in temperature, it is important that coatings applied on steel be flexible to prevent rapid failure.

Taber Abrasion - Coatings used on horizontal surfaces, such as floors, furniture, etc., which are subject to wear from traffic or handling should be resistant to abrasion.

Water Absorption - Coatings such as exterior stains, waterproofing coatings and mastic coatings should prevent the absorption of water, i.e., from rain, so as to protect the substrate.

Reagent Resistance Tests -

Cold Water - All coatings should be water resistant to prevent damage, if wet.

Xylol (Xylene) - Xylol simulates strong solvents which may be present in industrial operations.

Mineral spirits - Many household cleaners contain solvents which are, or are similiar to, mineral spirits.

Alcohol (100%) - Alcohol may be present in industrial operations.

Alcohol (50%) - This simulates a liquor spill.

Hot water - This simulates a spill of hot tea or coffee.

Butyl acetate - This simulates nail polish.

Hydrochloric acid - This acid may be present in industrial operations.

Color and Gloss Retention - Coatings exposed indoors are still subject to changes in color and/or gloss over long periods of time. Ultraviolet light accelerates the change.

Salt Fog Exposure - A major determination of corrosion resistance is exposure to a fog of a 5% salt solution. This simulates a seashore environment. In order to accelerate corrosion, an "X" is scored through the coating to expose the steel and simulate damage to the coating.

Accelerated Weathering - The apparatus combines artificial sunlight lamps and moisture condensation to simulate exposure conditions.

X CODE AND ABBREVIATIONS

The following code is used in preparing the tables in the Discussion of Results:

10 = Decidedly above average for the group
7 = Significantly above average
5 = Average or equivalent
3 = Significantly below average
0 = Decidedly below average for the group

The following ASTM Scoring Scheme has been used in the Test Data (Appendix II) to score subjective observations in order to avoid lengthy descriptions:

Score	Performance	or	Effect
10	Perfect		None
9	Excellent		Trace
8	Very good		Very slight
6	Good		Slight
4	Fair		Moderate
2	Poor		Severe
0	No value		Failed

The following units have been used in the Test Data (Appendix II). See the Test Procedure (Appendix III) for a complete description.

KU - Krebs units
Hrs - Hours
mgm - milligrams
mm - millimeters
ASTM - See appropriate test method

The following abbreviations have been used to avoid lengthy descriptions:

Tests: -
HCl - Hydrochloric acid
X - "X" scribed through coating to expose steel
Creep - Distance of corrosion from the "X"
Acc. - Accelerated
Check.- Checking
Crack.- Cracking

Products: -
CARB - CARB conforming
Conv. - Conventional
WB - Water base
HS - High solids
SF - Solvent free
Pow - Powder
-2 - Two component

Colors: -

Bge - Beige		Grn - Green
Blk - Black		Gry - Grey
Bwn - Brown		Org - Orange
Clr - Clear		TR - Tile Red
		Wht - White

Viscosity and Gloss: -
L - Low
H - High
V - Very

The following abbreviations have been used in describing the samples received from the cooperators (page 13):

I - Interior	WB - Water base	Conv - Conventional
E - Exterior	HS - High solids	g/l - grams per liter
G - Gloss	SF - Solvent free	% - % by volume
S - Semigloss	2 - 2 component	Gal - Gallon
ND - No data	3 - 3 component	qt - quart
	Z - Zinc rich	pt - pint

RMS - No price since product was supplied by a raw material supplier.